



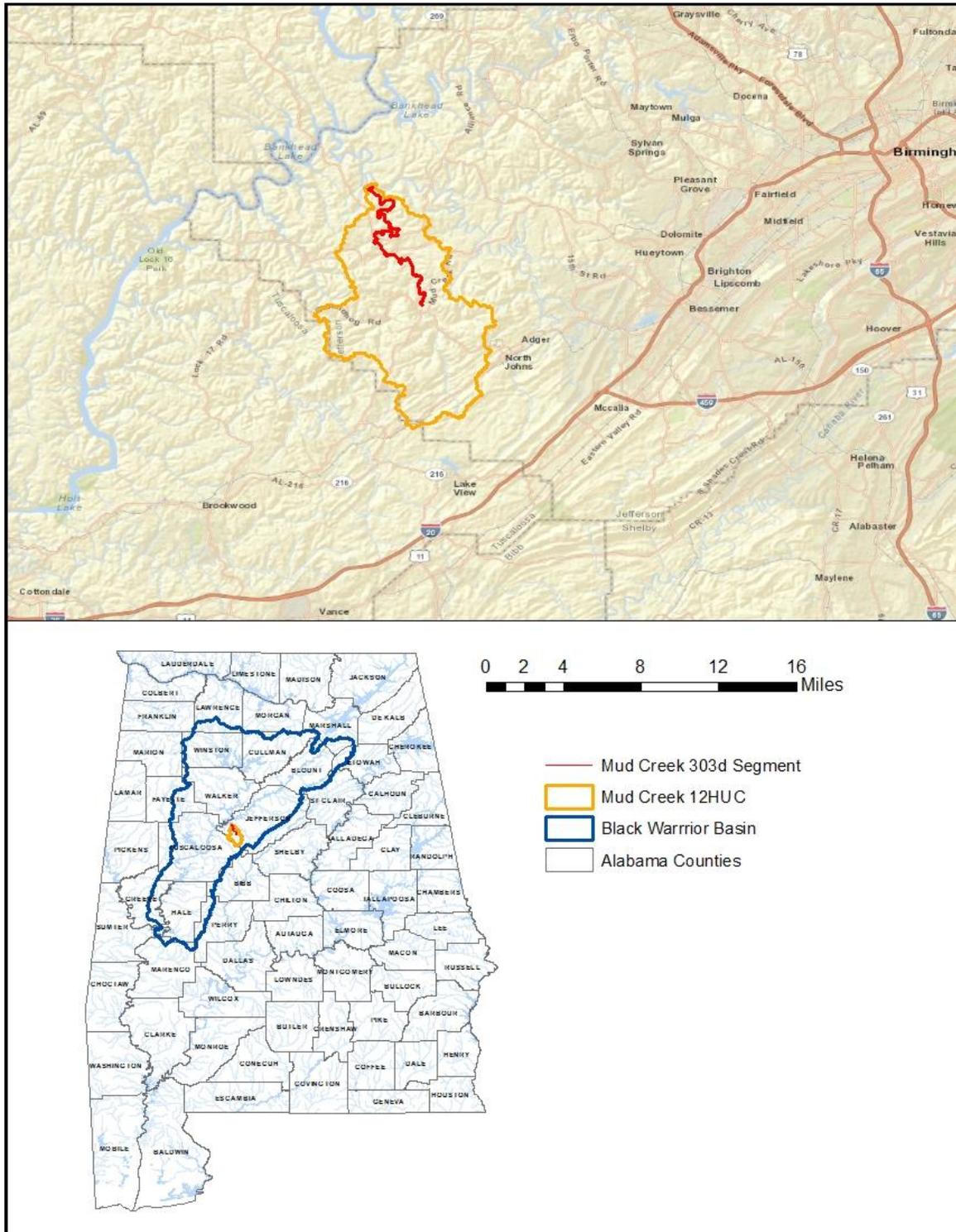
DRAFT
Delisting Decision for
Mud Creek

Waterbody ID # AL/03160112-0105-101

pH
Siltation(Habitat Alteration)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
February 2014

Figure I. Mud Creek in the Black Warrior River Basin



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1.0 Executive Summary

Mud Creek is located in the Black Warrior River Basin in central Alabama. The §303(d) listed portion of Mud Creek is west of Birmingham in the western portion of Jefferson County. The listed segment from Big Branch upstream to the confluence of Valley Creek was placed on the State of Alabama's §303(d) use impairment list in 1998 for pH and Siltation(Habitat Alteration). The source of the impairment was listed as an unknown source. Mud Creek is currently on the 2012 §303(d) list from Big Branch to Valley Creek (AL03160112-0105-101) for pH and siltation (habitat alteration) due to an unknown source. The listed portion of Mud Creek from Big Branch to Valley Creek has a designated use classification of Fish & Wildlife.

pH (i.e. potential of Hydrogen) is the measure of effective hydrogen-ion activity or concentration of a given solution in terms of relative acidity or alkalinity. The measure of pH is most commonly expressed in relation to a numeric scale ranging from 0 to 14 standard units (s.u.), in which a pH of 7 s.u. represents neutrality. pH values lower than 7 s.u. represent increasing acidity, and pH numbers greater than 7 s.u. represent increasing alkalinity. The pH of water determines the solubility (amount potentially dissolvable in water) and biological availability (amount accessible to aquatic life) of chemical constituents contained in the water.

In accordance with ADEM water quality standards the pH shall not be less than 6.0 s.u. nor greater than 8.5 s.u. for streams classified as Fish & Wildlife(F&W). In years 1978-1981 water quality data was collected on Mud Creek at two locations. Two of the seven samples were less than the minimum pH criterion of 6.0 s.u. As a result of this data, the 14.1 mile segment of Mud Creek was initially added to the 1998 §303(d) list by the Environmental Protection Agency (EPA).

ADEM uses both numeric and narrative criteria for siltation(habitat alteration). According to ADEM's Water Quality Criteria (Administrative Code 335-6-10), maximum turbidity cannot exceed 50 NTUs above background conditions for all classified waters. Siltation can also be quantified by comparing turbidity and total suspended solids (TSS) to the corresponding ecoregional reference guidelines. Median values were used to represent existing conditions of turbidity and TSS within the impaired waterbody. The weighted 90th percentile value for turbidity and TSS is listed as 10.1 NTU and 14 mg/L respectively.

ADEM has sampled Mud Creek at stations MUDJ-1 and MUDJ-100 in 2012 as part of the §303(d) Monitoring Program. None of the pH measurements at MUDJ-1 and MUDJ-100 were less than 6.0 s.u or greater than 8.5 s.u.. None of the turbidity measurements were greater than 50 NTU and the median value at both stations were less than the 90th percentile. The median value for Total Suspended Solids was less than the 90th percentile of the ecoreference site. Based on the 2013 indices by ecoregion and drainage area, the bioassessment results indicated the macroinvertebrate community to be in "Fair" condition. The overall habitat quality was categorized as "Sub-Optimal". These ratings indicate that there is no impairment due to siltation and the watershed is fully supporting its use classification of F&W.

This report addresses the results of the delisting analysis for pH and Siltation(Habitat Alteration) for the §303(d) listed segment of Mud Creek from Big Branch to Valley Creek. Based on the

assessment of all available water quality data, ADEM has determined that a pH and a Siltation(Habitat Alteration) impairment for Mud Creek does not exist. Therefore, ADEM will not develop a TMDL due to “more recent or accurate data” which is just cause for not listing a waterbody on the §303(d) list as stated in Title 40 of the Code of Federal Regulations (CFR), Part 130.7(b)(6)(iv).

2.0 Basis for §303(d) Listing

Section 303(d) of the Clean Water Act (CWA) as amended by the Water Quality Act of 1987 and EPA’s Water Quality Planning and Management Regulations [(Title 40 of the Code of Federal Regulations (CFR), Part 130)] require states to identify waterbodies which are not meeting water quality standards applicable to their designated use classifications. The identified waters are prioritized based on severity of pollution with respect to designated use classifications. Total maximum daily loads (TMDLs) for all pollutants causing violation of applicable water quality standards are established for each identified water. Such loads are established at levels necessary to implement the applicable water quality standards with seasonal variations and margins of safety. The TMDL process establishes the allowable loading of pollutants, or other quantifiable parameters for a waterbody, based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water-quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Alabama has identified the 14.12 mile segment of Mud Creek from Big Branch to Valley Creek as being impaired for pH and Siltation(Habitat Alteration). The §303(d) listing was originally reported on Alabama’s 1998 §303(d) List, and subsequently included on the 2000, 2002, 2004, 2006, 2008, 2010 and 2012 lists. The source of the impairment on the 2012 §303(d) list is identified as “unknown source.”

Water quality data from 1978-1981 was used to list Mud Creek for pH on the 1998 §303(d) list that is located in Table 2-1. That data, collected by USGS, indicated pH values less than 6.0 standard units (s.u.) for two of the seven samples collected. Total Suspended Solids indicated that four of the six single samples and the median value of 21.5 were higher than the current 90th percentile ecoreference value of 14.0 mg/L.

Table 2-1. 1978-1981 Data for Mud Creek

Site	Date	Time	Water Temp (°C)	Flow (cfs)	pH (s.u.)	DO (mg/L)	TSS (mg/L)	NH ₃ + NH ₄ -N (mg/L)
02462065	7/9/1980	11:00	26.5	5.6	5	8	16	
02462065	7/22/1980	11:30	26	5.4	5.2	7.4		0.08
02462065	5/19/1981	15:30	24	40	7.4		27	
02462080	4/17/1978	13:00	19	28	6.7	9.2	8.0	0.1
02462080	5/17/1980	13:15	19	837	6		880	
02462080	7/23/1980	12:45	25	10	6.5	8.4	7.0	0.05
02462080	5/19/1981	12:00	21	59	6.2	8.2	1210	

3.0 *Technical Basis for Delisting Decision*

3.1 *Water Quality Target Identification*

pH Criteria: According to ADEM’s Water Quality Criteria, Administrative Code 335-6-10-.09(5)(e)2, the pH shall not “be less than 6.0, nor greater than 8.5” in streams classified as Fish & Wildlife. For the purpose of this delisting, a minimum pH of 6.0 s.u. and a maximum pH of 8.5 s.u. are established, except where naturally occurring conditions are otherwise present.

Siltation Criteria: For purposes of listing and delisting decisions regarding siltation, ADEM uses both numeric and narrative criteria. According to ADEM’s Water Quality Criteria (Administrative Code 335-6-10), maximum turbidity cannot exceed 50 NTUs above background conditions for all classified waters. Siltation can also be quantified by comparing turbidity and total suspended solids (TSS) to the corresponding ecoregional reference guidelines. Median values were used to represent existing conditions of turbidity and TSS within the impaired waterbody. The weighted 90th percentile value for turbidity and TSS is listed as 10.1 NTU and 14 mg/L respectively.

According to the 303(d) pollutant list definition, siltation causes excessive amounts of sediment which degrade the habitat of aquatic organisms and interfere with the stream’s aquatic community. For the purpose of determining use support for siltation, the following guidelines regarding interpretation of biological data will be used:

- Fully Supporting - Macroinvertebrates determined to be Excellent (Unimpaired), Good (Slightly Impaired), and Fair (Moderately Impaired) rating if Chemical/Physical/Field Data indicates compliance.
- Partial Supporting - Macroinvertebrates determined to be Fair (Moderately Impaired) and Chemical/Physical/Field Data indicates impairment.
- Not Supporting - Macroinvertebrates determined to be Poor (Severely Impaired) and Chemical/Physical/Field Data indicates impairment.

Habitat assessment scores are based on a variety of habitat conditions. The ratings include optimal, suboptimal, marginal or poor. The habitat assessment categories and interpretations are listed in table 3.

Table 3-1. Biometric Interpretation of Habitat Assessment

METRIC	Category	INTERPRETATION
Habitat Assessment	Optimal	Conditions meet natural expectations
	Sub-optimal	Satisfies expectations under most conditions
	Marginal	Moderate levels of degradation
	Poor	Substantially altered

3.2 Data Availability and Analysis

Water quality data on Mud Creek has been collected by ADEM at stations MUDJ-1 and MUDJ-100. Mud Creek was originally listed based on data collected by USGS during years 1978-1981. Two of the seven (29%) pH measurements collected in 1978-1981 were less than 6.0 s.u. The pH of the samples ranged from 5.0 to 7.4 s.u. The data is located in Table 2-1.

In April through November 2012, ADEM collected monthly samples at Stations MUDJ-1 and MUDJ-100 as part of the §303(d) Monitoring Program. These station locations are described in Table 3-2 and depicted in Figure 3-1. At MUDJ-1 and MUDJ-100, none of the pH measurements were less than 6.0 s.u or higher than 8.5 s.u. In addition to pH, Mud Creek was also sampled for the normal Field Parameters, and Conventional Lab Parameters as outlined in the 2012 Surface Water Quality Monitoring Plans. The field measurements are located in Table 7-1, and the laboratory data is located in Table 7-2.

Table 3-2. Mud Creek Sampling Station Descriptions

Station ID	Stream Name	Location Description	Latitude	Longitude
MUDJ-1	Mud Creek	Mud Creek at CR 54 (Lock 17Rd)	33.44585	-87.19014
MUDJ-100	Mud Creek	Mud Creek approx. 1 mi above confluence with Valley Cr.	33.484467	-87.18443

Figure 3-1. ADEM Sampling Stations on Mud Creek

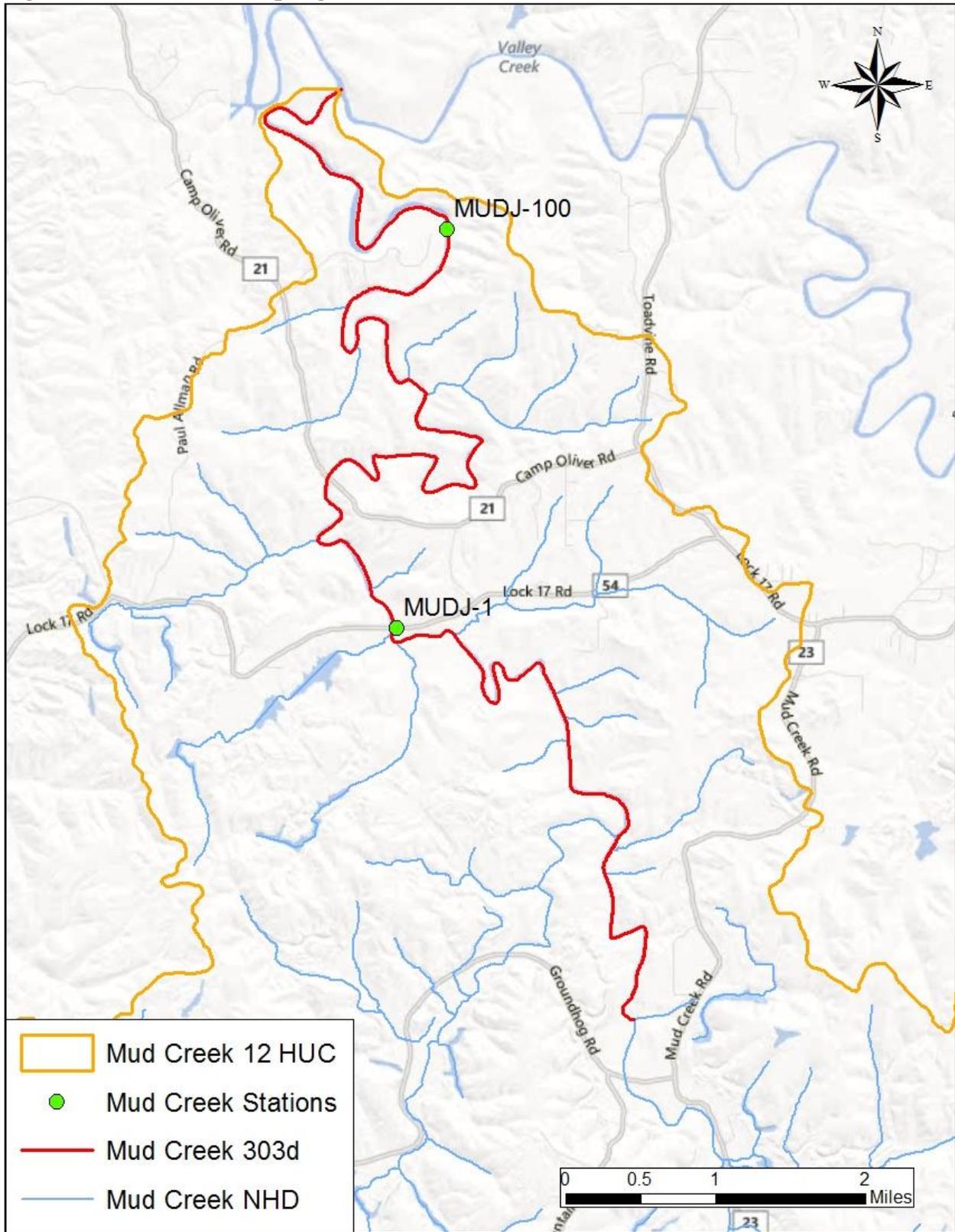
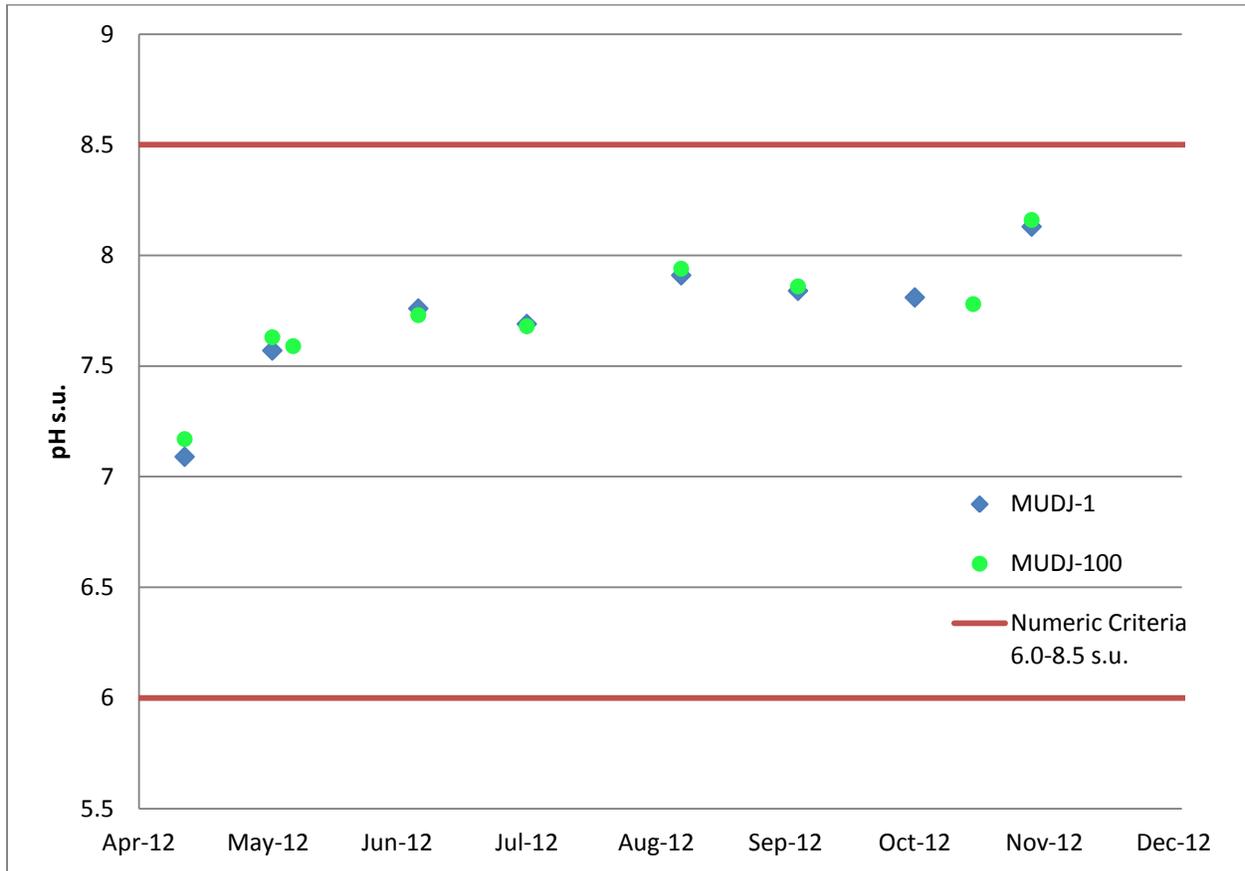


Figure 3-2. Statistical Comparison of pH Measurements for Mud Creek and Numeric Criteria



3.3 Discussion of Iron and Pyrite Weathering Chemistry

One likely cause of the low pH values that were the basis for listing Mud Creek, is the presence of iron. Iron concentrations measured by ADEM in this region as a whole on average are higher than iron concentrations measured across the state. These higher than normal iron concentrations are likely the cause of the lower pH values. Elevated iron concentrations can be explained by looking at maps of coal deposits in Alabama. USGS Miscellaneous Field Studies Map MF-2333 Version 1.0, 'Distribution of a Suite of Elements Including Arsenic and Mercury in Alabama Coal', has maps depicting the outline of the Warrior coal field (Figure 3-4), iron concentrations in the Warrior coal field, and pyritic sulfur in the Warrior coal field (Figure 3-5).

Figure 3-3. Warrior Coal Field in Alabama

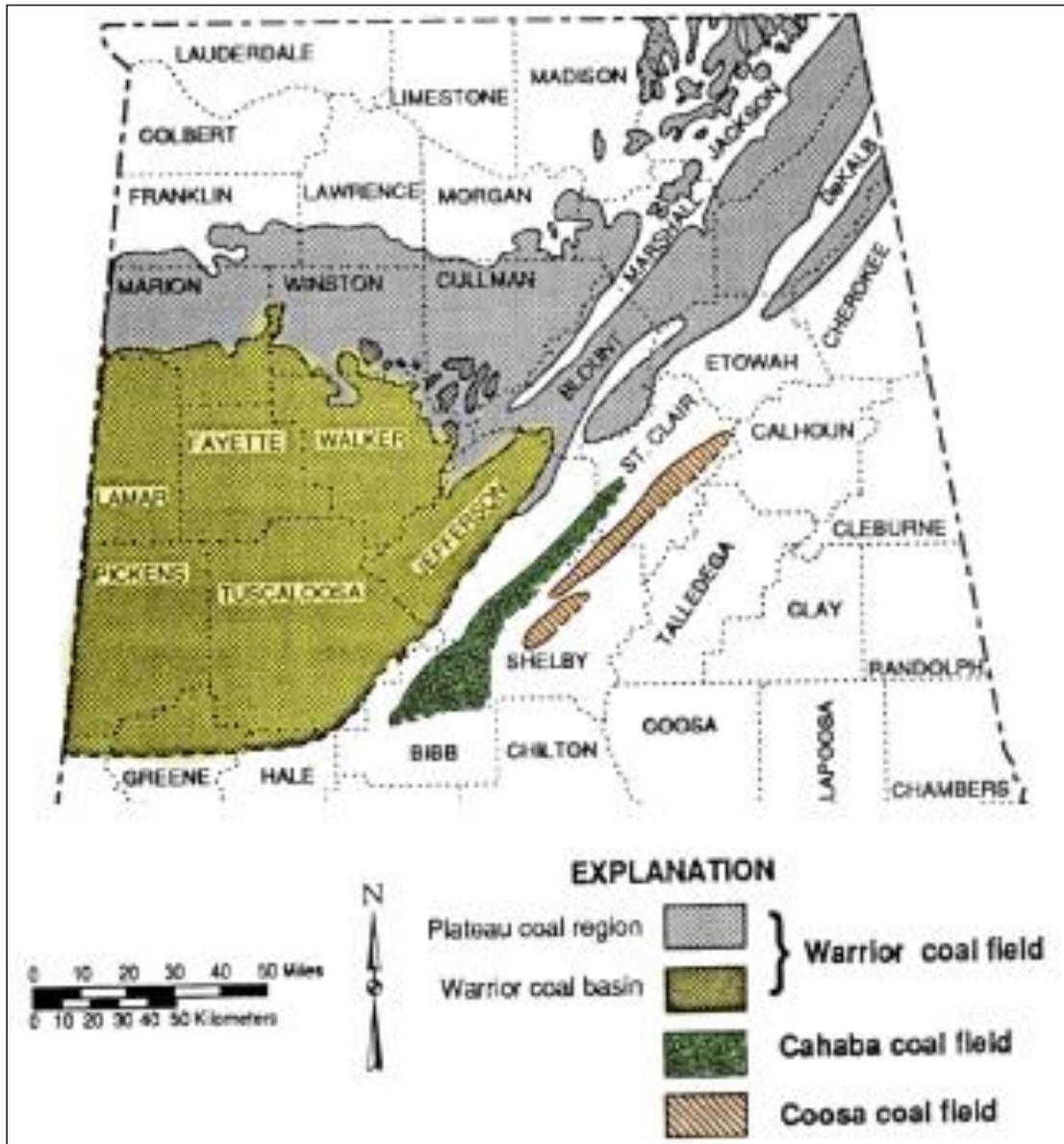
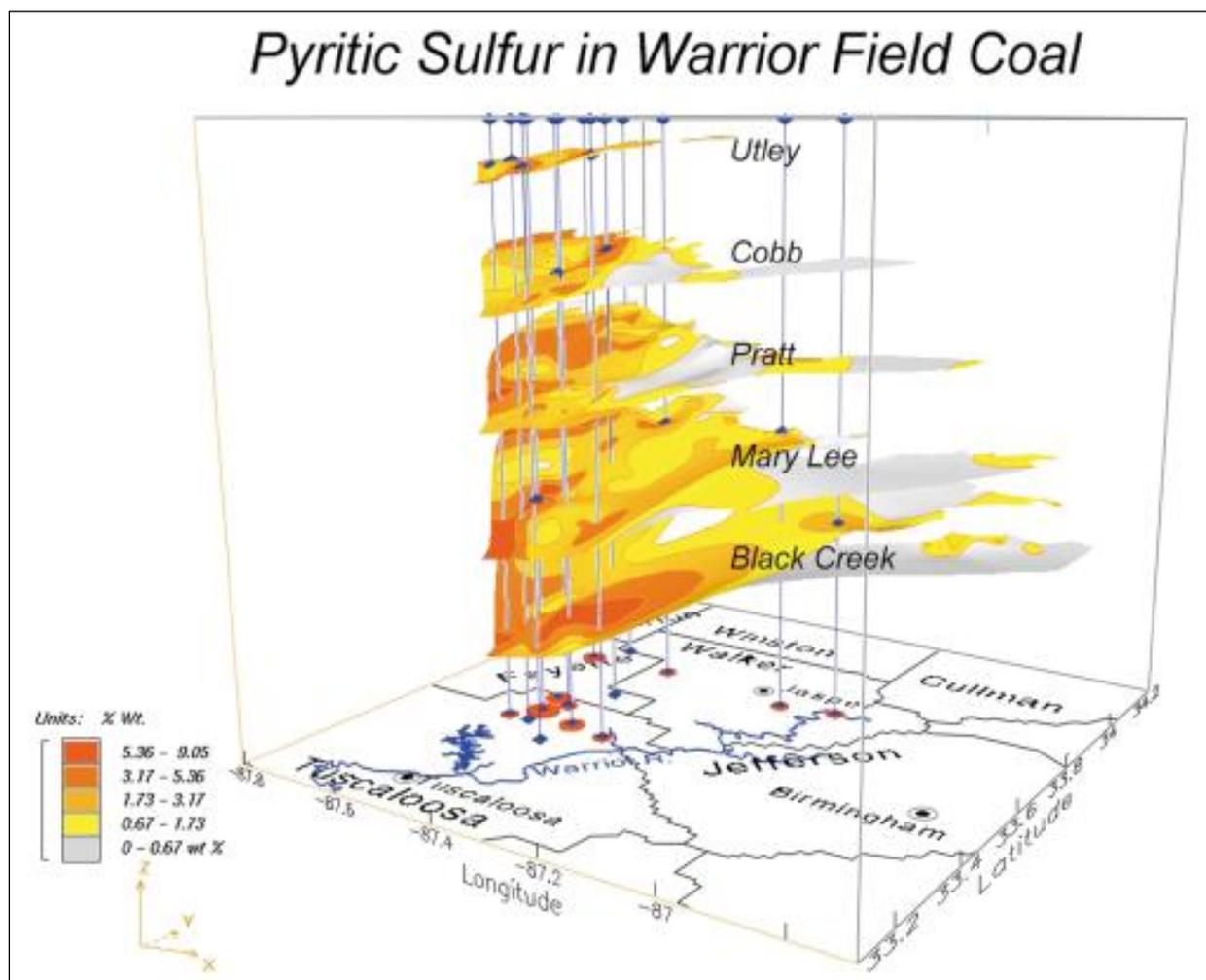


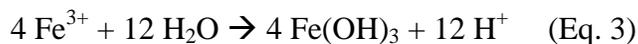
Figure 3-4 shows that the Mud Creek watershed is within the Warrior coal basin of the Warrior coal field. While no samples used to generate Figure 3-6 were taken in the Mud Creek watershed, it illustrates the concentrations of pyritic sulfur in the area surrounding the Mud Creek watershed.

Figure 3-4. Pyritic Sulfur in the Warrior Coal Field in Alabama



The chemistry of pyrite weathering can explain the high iron concentrations and low pH values. One source of iron in surface waters is iron-bearing groundwater that flows through areas with pyrite formations. Pyrite is a term used to collectively describe all iron disulfide (FeS_2) minerals. A series of chemical weathering reactions of pyrite occur when it is exposed to an oxidizing environment. The reactions are similar to geologic weathering, but the rates of reaction are higher. The reactions can release acidity, metals, and other components into streams and the surrounding environment.

In the initial step, pyrite reacts with water and oxygen to form ferrous iron, sulfate and acidity (Eq. 1). Then the ferrous iron is converted to ferric iron (Eq. 2). In the third reaction ferric iron is hydrolyzed with water to form solid ferric hydroxide and more acidity (Eq. 3). In conditions with pH less than 3.5 s.u. the solid ferric hydroxide doesn't form and ferric iron remains in solution. At higher pH values a precipitate commonly referred to as yellowboy forms. The final step involves the oxidation of pyrite by ferric iron (Eq. 4).



This cyclic generation of acid by iron takes place quite rapidly and can continue until the supply of ferric iron or pyrite is used up. Oxygen is not required for the fourth reaction and this overall reaction is one of the most acid producing weathering processes in nature. This reaction can take place in groundwater seeping through formations containing pyrite. This is the likely cause of higher than average iron concentrations and lower pH values that were observed historically in Mud Creek.

3.4 Soils of the Mud Creek Watershed

The low pH values in Mud Creek can also be linked to soil type. The NRCS SSURGO soils data contains information on soil type, physical properties, chemical properties, and other information. Data is available for the surface layer, a depth range, or all layers of the soil. One of the chemical properties is pH using the 1:1 water method. A crushed soil sample is mixed with an equal amount of water, and a pH measurement is made of the soil/water suspension. Table 3-3 lists the 1:1 water pH for the soil types in the Mud Creek watershed. The pH ratings for the soil types in the Mud Creek watershed range from 4.6 to 6.2 s.u.

Table 3-3. SSURGO 1:1 Water pH for Soil Types in the Mud Creek Watershed

County	Soil Type	pH Rating
Jefferson	Allen fine sandy loam, 8 to 15 percent slopes	5.0
Jefferson	Holston loam, 2 to 8 percent slopes	5.0
Jefferson	Montevallo-Nauvoo association, steep	5.3
Jefferson	Nauvoo fine sandy loam, 2 to 8 percent slopes	5.3
Tuscaloosa	Nauvoo fine sandy loam, 4 to 10 percent slopes	5.0
Jefferson	Nauvoo fine sandy loam, 8 to 15 percent slopes	5.3
Jefferson	Palmerdale complex, steep	4.6
Tuscaloosa	Palmerdale very shaly loam, 6 to 45 percent slopes	4.6
Jefferson	Sullivan-State complex, 0 to 2 percent slopes	6.2
Jefferson	Townley-Nauvoo complex, 8 to 15 percent slopes	4.6

3.5 Siltation Analysis

All turbidity data collected at Stations MUDJ-1 and MUDJ-100 was reported below ADEM's turbidity criterion of 50 NTUs above background. Also, both stations TSS median values are below reference conditions, therefore, the numeric data meets applicable criteria with respect to siltation and habitat alteration. The macroinvertebrate assessment scores for low gradient and high gradient both resulted in fair ratings, which according to ADEM's use support methodology is considered to be fully supporting for a stream classified Fish & Wildlife. The habitat assessment resulted in a sub-optimal score which is interpreted as satisfies expectations under most conditions. Reference Tables 3-4, 3-5, and 3-6 for the full assessment reports. The results from the instream data, macroinvertebrate and habitat assessments show that Mud Creek is fully supporting its use classification and collectively provide sufficient evidence to delist the segment for siltation and habitat alteration.

Table 3-4. MUDJ-100 & MUDJ-1 Siltation Data

MUDJ-1		
	TSS mg/L	Turb NTU
Mean:	5.13	2.976
Median:	2.50	2.890
75th %tile:	5.50	3.030
90th %tile:	12.40	4.134
Ecoref 90th%tile:	14.0	10.1
Median<Eco90%tile:	yes	yes
MUDJ-100		
	TSS mg/L	Turb NTU
Mean:	2.50	4.43
Median:	2.50	2.72
75th %tile:	3.25	3.94
90th %tile:	4.3	7.99
Ecoref 90th %tile:	14.0	10.1
Median<Eco90%tile:	yes	yes

Table 3-5. Habitat Assessment at MUDJ-100 on May 8, 2012

Habitat Assessment	Rating	MUDJ-100	5/8/2012
RR			
Instream Habitat Quality	64		Sub-optimal (59-70)
Sediment Deposition	67		Sub-optimal (59-70)
Sinuosity	48		Marginal (45-64)
Bank and Vegetative Stability	75		Optimal >74
Riparian Buffer	51		Marginal (50-69)
Habitat Assessment Score	156		
% Maximum Score	65		Sub-optimal (59-70)

Table 3-6. Macroinvertebrate Assessments at MUDJ-100

Macroinvertebrate Assessment MUDJ-100 High Gradient			
	Results	Scores	Rating
Taxa richness measures			
		(0-100)	
# Ephemeroptera (mayfly) genera	8	67	Fair (47-70)
# Plecoptera (stonefly) genera	2	33	Fair (32-49)
# Trichoptera (caddisfly) genera	9	75	Good (67-83)
Taxonomic composition measures			
% Non-insect taxa	13	50.0	Fair (49.5-74.1)
% Non-insect organisms	9	76.5	Fair (62.8-93.9)
% Plecoptera	2	10.0	Poor (6.6-13.1)
Tolerance measures			
Beck's community tolerance index	8	28.6	Poor (20.3-40.7)
WMB-I Assessment Score	-	49	Fair (49-72)
Macroinvertebrate Assessment MUDJ-100 Low Gradient			
	Results	Scores	Rating
Taxa richness measures			
# EPT genera	19	76	Good (57-78)
Taxonomic composition measures			
% Non-insect taxa	13	62.5	Fair (61.9-92.7)
% Plecoptera	2	10.0	Good (5.7-52.8)
% Dominant taxa	11	98.3	Excellent (>=85.3)
Functional composition measures			
% Predators	10	36.0	Fair (30.2-45.2)
Tolerance measures			
Beck's community tolerance index	8	36.4	Good (31.9-65.9)
% Nutrient tolerant organisms	26	73.3	Fair (50.9-76.2)
WMB-I Assessment Score	-	56	Fair (38-56)

4.0 Source Assessment

4.1 Non-Point Sources

Land use for the Mud Creek watershed was determined using ArcMap with land use datasets from 2006. Land use information for this assessment was derived from the 2006 National Land Cover Dataset (NLCD) Zone 46. Figure 4-1 is a map of the land uses in the Mud Creek watershed and Table 4-1 contains a numerical breakdown of the land uses. The total drainage

area for the Mud Creek watershed is ~51.2 square miles. Overall the watershed can be considered rural with 91% of the land cover being forested.

Figure 4-1. Land Use Map for the Mud Creek Watershed

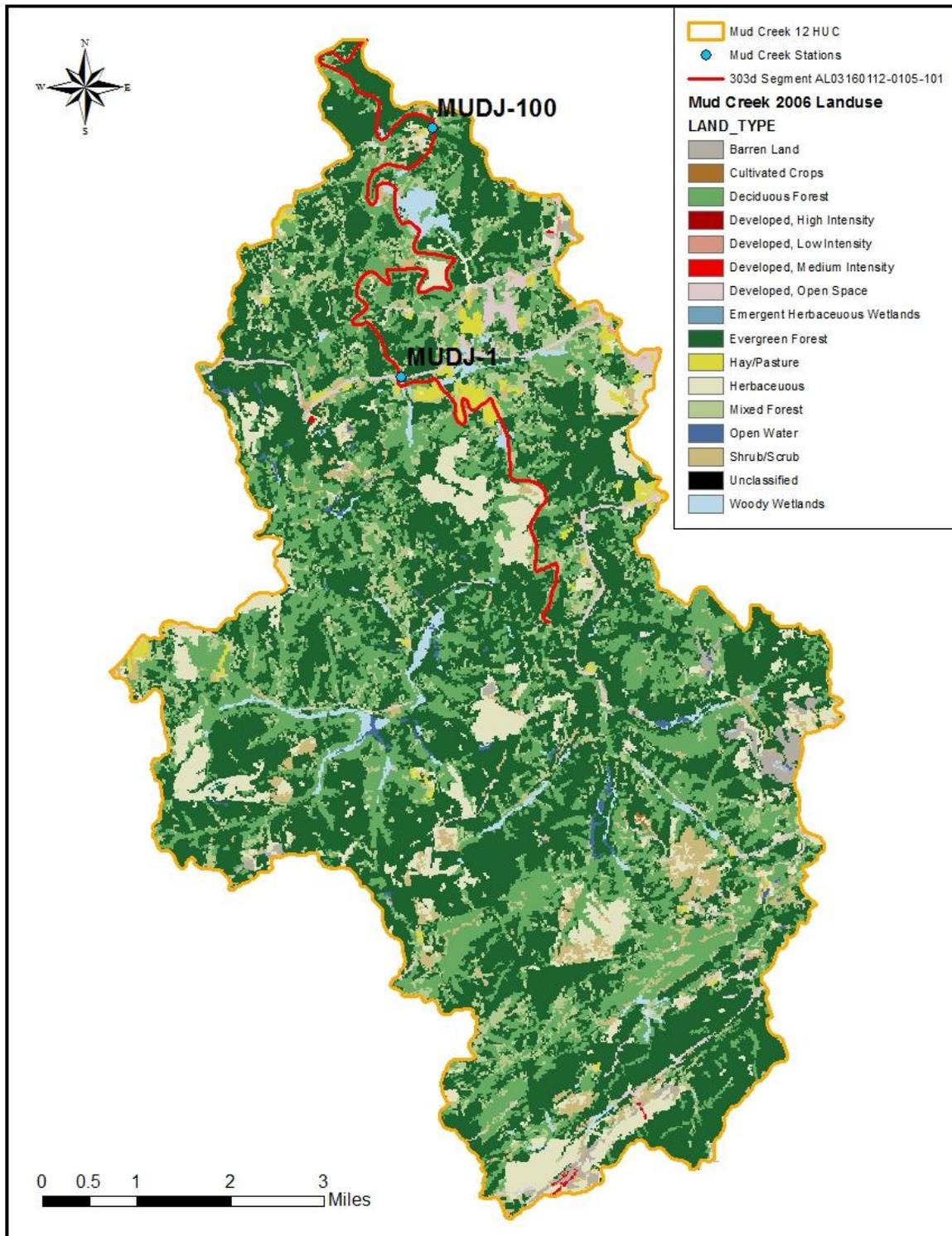


Table 4-1. Land Use in the Mud Creek Watershed.

Landuse	Acres	Square Miles	Percent
Open Water	142	0.22	0.43%
Developed, Open Space	670	1.05	2.05%
Developed, Low Intensity	14	0.02	0.04%
Developed, Medium Intensity	16	0.02	0.05%
Barren Land	343	0.54	%
Deciduous Forest	8244	12.88	25.16%
Evergreen Forest	15389	24.05	46.97%
Mixed Forest	2988	4.67	9.12%
Shrub/Scrub	1231	1.92	3.76%
Pasture/Hay	391	4.23	1.19%
Cultivated Crops	9	0.61	0.03%
Woody Wetlands	624	0.01	1.90%
Herbaceous	2704	0.98	8.25%
Total	32764	51.19	100.00%
Agriculture	400	0.62	1.22%
Forest	29949	46.80	91.41%
Other	2415	3.77	7.37%
Total	32764	17.62	100.00%

4.2 Point Sources

There is only one facility permitted under the NPDES program to discharge in the Mud Creek watershed, Table 4-2 and Figure 4-2. The Weller Mine is permitted to discharge an active mining effluent discharge to an unnamed tributary to Mud Creek. This is a newly permitted facility with a final permit issued on October 28, 2012. Currently there have not been any DMRs submitted by the permittee.

Table 4-2. NPDES Permitted Discharges in the Mud Creek Watershed

Facility Name	NPDES Permit	Permit Type	Discharge #'s	Receiving Waters
Weller Mine	AL0081558	Mining	DSN008-1 – DSN032-1	UT to Mud Creek

5.0 Conclusions

Based on an examination of all available water quality data and information related to Mud Creek from Big Branch to Valley Creek, ADEM has determined that a pH and a siltation(habitat alteration) impairment does not currently exist. Therefore, ADEM will not develop a TMDL due to “more recent or accurate data” which is just cause for delisting a waterbody in accordance with Title 40 of the Code of Federal Regulations (CFR), Part 130.7(b)(6)(iv). Mud Creek will be proposed for delisting as a part of the development process for Alabama’s *2014 §303(d) List of Impaired Waters*.

6.0 Public Participation

As part of the public participation process, this Delisting Decision (DD) will be placed on public notice and made available for review and comment. The public notice will be prepared and published in the major daily newspapers in Montgomery, Huntsville, Birmingham, and Mobile, as well as submitted to persons who have requested to be on ADEM’s postal and electronic mailing distributions. In addition, the public notice and subject DD will be made available on ADEM’s Website: www.adem.state.al.us. The public can also request paper or electronic copies of the DD by contacting Mr. Chris Johnson at 334-271-7827 or cljohnson@adem.state.al.us. The public will be given an opportunity to review the DD and submit comments to the Department in writing. At the end of the public review period, all written comments received during the public notice period will become part of the administrative record. ADEM will consider all comments received by the public prior to final completion of this DD and subsequent submission to EPA Region 4 for final approval.

Appendix 7.1 References

ADEM Administrative Code, 2013. Water Quality Program, Chapter 335-6-10, Water Quality Criteria, and Chapter 335-6-11 Use Classifications for Interstate and Intrastate Waters.

Alabama's §303(d) Monitoring Program. ADEM.

Alabama's Ambient Water Quality Monitoring Program. ADEM.

Alabama's Water Quality Assessment and Listing Methodology. 2012. ADEM.

Alabama Department of Environmental Management, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010 and 2012 §303(d) Lists. ADEM.

Griffith, G.E., J.M. Omernik, J.A. Comstock, S. Lawrence, G. Martin, A. Goddard, V.J. Hulcher, T. Foster. 2001. Ecoregions of Alabama and Georgia. Color poster with map, descriptive text, summary tables and photographs. U.S. Geological Survey, Reston VA.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database for Jefferson and Tuscaloosa Counties in Alabama.

United States Environmental Protection Agency. 1991. Guidance for Water Quality-Based Decisions: The TMDL Process, Office of Water, EPA 440/4-91-001.

USGS Miscellaneous Field Studies Map MF-2333 Version 1.0. Distribution of a Suite of Elements Including Arsenic and Mercury in Alabama Coal. (<http://pubs.usgs.gov/mf/2000/mf-2333/mf2333so.pdf>)

Appendix 7.2

Water Quality Data

Table 7-1. Field Data Collected at MUDJ-1 and MUDJ-100 in 2012

Station ID	Activity Date	Air Temp (°C)	Water Temp (°C)	pH (s.u.)	Conductivity (µmhos @ 25°)	DO (mg/l)	Turbidity (ntu)	Flow (cfs)	Flow Measured
MUDJ-1	4/12/2012	18	14.4	7.09	514	10.93	2.69		
MUDJ-1	5/3/2012	23	20.64	7.57	639	8.19	33.1	27.80	YES-ADEM
MUDJ-1	6/7/2012	28	21.57	7.76	820	8.29	4.38	10.12	YES-ADEM
MUDJ-1	7/3/2012	33	25.45	7.69	952	6.74	2.73	5.29	YES-ADEM
MUDJ-1	8/9/2012	25	25.65	7.91	996	6.94	2.29	7.80	
MUDJ-1	9/6/2012	24	24.6	7.84	848	7.6	3.14	34.15	YES-ADEM
MUDJ-1	10/4/2012	25	18.33	7.81	708	9.13	2.27	25.45	YES-ADEM
MUDJ-1	11/1/2012	16	9.95	8.13	800	10.65	1.53	8.07	YES-ADEM
MUDJ-100	4/12/2012	17	15.47	7.17	486	10.49	2.72		
MUDJ-100	5/3/2012	21	21.26	7.63	670	7.97	3.87	25.13	YES-ADEM
MUDJ-100	5/8/2012	26.6	22.42	7.59	631	7.87	5.54	19.31	YES-ADEM
MUDJ-100	6/7/2012	30	23.2	7.73	740	8.22	1.72	9.24	YES-ADEM
MUDJ-100	7/3/2012	35	25.61	7.68	932	6.39	3.94	5.51	YES-ADEM
MUDJ-100	8/9/2012	26	25.99	7.94	941	7.34	1.24	10.14	YES-ADEM
MUDJ-100	9/6/2012	28	24.69	7.86	906	7.4	2.01	32.14	YES-ADEM
MUDJ-100	10/18/2012	24	17.53	7.78	541	8.39	17.8		NO-FLOW CONDITIONS HAZARDOUS
MUDJ-100	11/1/2012	19	9.82	8.16	793	10.12	1	9.16	YES-ADEM

Table 7-2. Lab Data Collected at MUDJ-1 and MUDJ-100 in 2012

Station ID	Activity Date	E Coli (col/100mL)	Chl A (µg/l)	Alk Tot (mg/l)	Hardness (mg/l)	CBOD ₅ (mg/l)	TSS (mg/l)	TDS (mg/l)	Total P (mg/l)	NO ₃ +NO ₂ N (mg/l)	NH ₃ -N (mg/l)	TKN (mg/l)	DRP (mg/l)
MUDJ-1	4/12/2012			45.8		1	1	363	0.006	0.089	0.01	0.257	0.005
MUDJ-1	5/3/2012			60.9		2	18	439	0.012	0.121	0.01	0.803	0.006
MUDJ-1	6/7/2012			70.6		2	10	633	0.027	0.04	0.01	0.152	0.006
MUDJ-1	7/3/2012			87.2		2	4	688	0.005	0.0673	0.01	0.536	0.006
MUDJ-1	8/9/2012			93.5		2	3	764	0.009	0.04	0.028	0.04	0.005
MUDJ-1	9/6/2012			71.6		2	2	620	0.009	0.078	0.028	0.088	0.016
MUDJ-1	10/4/2012			70.8		2	2	526	0.009	0.072	0.028	0.491	0.016
MUDJ-1	11/1/2012			79.4		2	1	537	0.018	0.006	0.028	0.176	0.009
MUDJ-100	4/12/2012	39.3	1	43.7	214	1	1	341	0.012	0.077	0.01	0.14	0.004
MUDJ-100	5/3/2012			65.4		2	3	461	0.008	0.125	0.01	0.338	0.005
MUDJ-100	6/7/2012	16	1	62.3	340	2	2	563	0.007	0.028	0.01	0.161	0.006
MUDJ-100	7/3/2012			86.6		2	5	662	0.011	0.0395	0.01	0.219	0.005
MUDJ-100	8/9/2012	39.9	1	86.6	409	2	4	699	0.009	0.019	0.028	0.12	0.005
MUDJ-100	9/6/2012			83		2	1	663	0.009	0.069	0.028	0.129	0.005
MUDJ-100	10/18/2012	980.4	1	55.2	252	2	3	389	0.015	0.018	0.028	0.137	0.008
MUDJ-100	11/1/2012			71.3		2	1	514	0.009	0.006	0.028	0.141	0.006

Table 7-3. Metals Data Collected at MUDJ-100 in 2012

Station ID	Activity Date	Ag Dissolved (µg/l)	Al Total (mg/l)	Ca Total (mg/l)	Fe Dissolved (mg/l)	Fe Total (mg/l)	Hg Dissolved (µg/l)	Mg Total (mg/l)	Mn Dissolved (mg/l)	Mn Total (mg/l)
MUDJ-100	4/12/2012	1	0.037	40.2	0.1	0.216		27.5	0.104	0.117
MUDJ-100	6/7/2012	1	0.03	63.3	0.1	0.125		44.1	0.082	0.104
MUDJ-100	8/9/2012	1	0.03	70.4	0.1	0.1		56.6	0.076	0.091
MUDJ-100	10/18/2012	1	0.289	47.1	0.1	0.653		32.6	0.053	0.066

Table 7-5. ADEM Reference Station Field Measurements for Ecoregion 68f

Station ID	Activity Date	Air Temp (°C)	Water Temp (°C)	pH (s.u.)	Conductivity (µmhos @ 25°)	DO (mg/l)	Turbidity (ntu)	Flow (cfs)	Flow Measured
BERT-4	5/6/1997		18	5.7	30	6.8	10.2	9.6	
BERT-4	3/20/2002	23	18	7.1	31	9.2		36.2	YES-ADEM
BERT-4	4/18/2002	27	18	6.9	36	8		11.1	YES-ADEM
BERT-4	5/7/2002	24	19	7.5	35	9.5		15	YES-ADEM
BERT-4	6/4/2002	35	26	6.6	43.8	7.6	10.8	0.1	NO-VISIBLE, BUT NOT MEASURABLE WITH METER
BERT-4	6/6/2002	23	23	8.1	60	7.9		3.2	YES-ADEM
BERT-4	7/2/2002	25	23	8.6	49	7.9		3.3	YES-ADEM
BERT-4	8/8/2002	32	26	8.7	66	5.6			NO-VISIBLE, BUT NOT MEASURABLE WITH METER
BERT-4	10/22/2002	23	17	6.6		8.8		6.1	YES-ADEM
BERT-4	11/19/2002	18	12	7.4	100	9.6		21	YES-ADEM
BERT-4	3/11/2003	20	11.52	6.67	149	12.9	29.1	38	YES-ADEM
BERT-4	4/7/2003	23	15.36	6.24	37	10.1	52.5		NO-FLOW CONDITIONS HAZARDOUS
BERT-4	4/29/2003	27	20	6.5	116.5	9.1	11.7	26.6	YES-ADEM
BERT-4	5/13/2003	25	16.97	6.48	89	9.99	14.5	20.7	YES-ADEM
BERT-4	6/16/2003	30	21.82	6.86	43	8.82	12.3	22.1	YES-ADEM

Station ID	Activity Date	Air Temp (°C)	Water Temp (°C)	pH (s.u.)	Conductivity (µmhos @ 25°)	DO (mg/l)	Turbidity (ntu)	Flow (cfs)	Flow Measured
BERT-4	7/8/2003	29	26	7.1	45.3	7.7	8.76	8.1	YES-ADEM
BERT-4	7/9/2003	28	23.15	6.69	173	8.58		10.7	YES-ADEM
BERT-4	7/23/2003								NO-NOT REQUIRED
BERT-4	8/12/2003	27	23	6.15	47	7.68	3.1	1.8	YES-ADEM
BERT-4	9/24/2003	23	18.74	6.76	161	9.76	73.6	3.8	YES-ADEM
BERT-4	10/27/2003	18	15.9	6.52	100	7.93	4.1	2.9	YES-ADEM
BERT-4	11/20/2003	13	11.56	7.38	88	10.47	35	9.1	YES-ADEM
BERT-4	3/27/2007	29	20	6.6	57.5	8.9	5.49	3	YES-ADEM
BERT-4	4/25/2007	30	20	6.4	935.4	8.5	8.32	1.1	YES-ADEM
BERT-4	5/9/2007	15	17.19	6.71	152.5	7.72	3.3	0.42	YES-ADEM
BERT-4	5/29/2007	34	22.7	7.55	98.8	7.97	7.82		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
BERT-4	6/26/2007								NO-NONCONTIGUOUS POOLS/DRY STREAMBED
BERT-4	7/18/2007								NO-NONCONTIGUOUS POOLS/DRY STREAMBED
BERT-4	8/22/2007								NO-NONCONTIGUOUS POOLS/DRY STREAMBED
BERT-4	1/14/2011	10	1.04	7.23	90	14.38	5.01	5.812	YES-ADEM
BERT-4	1/25/2011	6	5.64	6.59	110	13.23	9.75	6.922	YES-ADEM
BERT-4	2/9/2011	9	6.25	6.74	58	13.54	6.03	18.45	YES-ADEM
BERT-4	2/22/2011	20	16.13	7.9	61	11.31	5.62	4.487	YES-ADEM
BERT-4	3/18/2011	26	15.02	6.15	44	11.13	9.88	33.575	YES-ADEM
BERT-4	3/30/2011	13	13.57	6.69	46	10.33	14.1		DATA COLLECTED BUT LOST
BERT-4	4/13/2011	25	17.18	7.47	50	10.19	7.5		NO-METER MALFUNCTIONED
BERT-4	5/4/2011	22.8	16.48	7.09	43	9.8	11.3	10.0924	YES-ADEM
BERT-4	5/11/2011	32	22.33	6.59	51	9.5	5.65	4.009	YES-ADEM

Station ID	Activity Date	Air Temp (°C)	Water Temp (°C)	pH (s.u.)	Conductivity (µmhos @ 25°)	DO (mg/l)	Turbidity (ntu)	Flow (cfs)	Flow Measured
BERT-4	5/25/2011	32	24.67	7.33	60	8.63	4.36		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
BERT-4	6/8/2011	29.8	27.46	6.99	69.2	7.57	3.46	0.1091	YES-ADEM
BERT-4	6/15/2011	35	25.33	6.26	69	7.83	3.34		NO-METER MALFUNCTIONED
BERT-4	6/29/2011	32	25.79	7.3	74	8.24	3.38		
BERT-4	7/13/2011	28	28.66	7.08	125	7.23	5.35		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
BERT-4	7/27/2011	34	28.26	6.96	134	7.64	4.5		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
BERT-4	8/10/2011	33	24.57	6.92	70	8	19.1	1.0517	YES-ADEM
BERT-4	8/25/2011	38	26.56	6.82	92	7.22	10.1		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
BERT-4	4/2/2012	29.5	19.13	5.72	48.9	8.93	10.4	11.833	YES-ADEM
BERT-4	5/2/2012	26.2	22.55	6.79	54.7	7.89	5.25	0.821	YES-ADEM
BERT-4	5/8/2012	30.4	21.05	6.25	54.7	8.11	11.7	2.99	YES-ADEM
BERT-4	6/13/2012	30.1	23.8	6.51	56	7.94	28.8	1.252	YES-ADEM
BERT-4	8/8/2012	29.4	28.7	6.74	65.1	7.61	16.6		NO-VISIBLE, BUT NOT MEASURABLE WITH METER
BERT-4	9/5/2012	26.6	23.44	6.69	78	7.12	50.2	12.3331	YES-ADEM
BERT-4	9/26/2012	26.9	18.4	8.05	81.6	8.45	10.8	1.335	YES-ADEM
BERT-4	10/2/2012	17.7	18.95	6.78	73.4	8.48	19.2	16.1804	YES-ADEM
BERT-4	10/31/2012	14.92	9.54	6.77	73.2	9.78	7.76	1.5284	YES-ADEM
BERT-4	12/4/2012	19.2	11.24	6.7	72.6	10.38	6.13	2.524	YES-ADEM
BERT-4	12/17/2012	18.1	13.65	6.29	44.8	9.76	30		NO-FLOW CONDITIONS HAZARDOUS
BERT-4	1/9/2013	15.2	10.1	6.58	45	11.05	11.4	19.7144	YES-ADEM
BERT-4	1/22/2013	8.1	6.47	6.13	37.9	11.94	8.04	30.7606	YES-ADEM
BERT-4	2/5/2013	12.7	9.24	6.61	39.8	11.24	7.74	20.4735	YES-ADEM
BERT-4	2/19/2013	13.8	10.14	6.56	36.9	11.07	16.6	43.4763	YES-ADEM

Table 7-5. ADEM Reference Station Lab Measurements for Ecoregion 68f

Station ID	Activity Date	E Coli (col/100mL)	Chl A (µg/l)	Alk Tot (mg/l)	Hardness (mg/l)	CBOD ₅ (mg/l)	TSS (mg/l)	TDS (mg/l)	Total P (mg/l)	NO ₃ +NO ₂ N (mg/l)	NH ₃ -N (mg/l)	TKN (mg/l)	DRP (mg/l)
BERT-4	3/20/2002		4.01	33	9.14	1.1	12	32	0.04	0.033	0.1	0.15	0.01
BERT-4	4/18/2002		3.2	7	7.51		5	30	0.019	0.629	0.015	0.15	0.003
BERT-4	5/7/2002		0.53	12	8.59		3	47	0.035	0.071	0.015	0.15	0.017
BERT-4	6/6/2002		4.27	7	12.2	0.7	5	123	0.041	0.037	0.015	0.15	0.004
BERT-4	7/2/2002		0.33	12	12.7	1.2	12	69	0.043	0.277	0.015	0.2	0.001
BERT-4	8/8/2002		1.34	43	8.08	0.6	10	90	0.077	0.058	0.015	0.496	0.004
BERT-4	10/22/2002		1.78	19	13.2		10	118	0.041	0.003	0.068	0.236	0.007
BERT-4	11/19/2002		0.8	10	13.3	0.3	5	43	0.004	0.069	0.198	0.436	
BERT-4	3/11/2003			7	6	1.2	7	34	0.004	0.048	0.015	0.15	0.004
BERT-4	4/7/2003		517	6	10	0.9	7	144	0.004	0.133	0.023	0.15	0.004
BERT-4	5/13/2003			8	20	0.4	7	41	0.004	0.094	0.022	0.15	0.004
BERT-4	6/16/2003			10	34	4.6	7	37	0.004	0.091	0.015	0.15	0.004
BERT-4	7/9/2003			11	26		3	42	0.004	0.047	0.015	0.15	0.004
BERT-4	8/12/2003		2.13	15	22	0.2	4	43	0.05	0.095	0.04	0.315	0.009
BERT-4	9/24/2003			11	32	0.4	10	124	0.02	0.138	0.015	0.303	0.008
BERT-4	10/27/2003			18	38	1.2	3	70	0.02	0.004	0.015	0.179	0.712
BERT-4	11/20/2003		1.07	11	26	0.8	5	89	0.02	0.032	0.187	0.282	0.005
BERT-4	3/27/2007		1.6	9.6		1	16	57	0.06	0.003	0.015	0.15	0.068
BERT-4	4/25/2007		2.67	5.9		1	7	586	0.022	0.009	0.015	0.15	0.013
BERT-4	5/29/2007		2.14	16.3		1	9		0.019	0.046	0.015	0.15	0.011
BERT-4	1/14/2011			6.13			0.3	64		0.048			
BERT-4	1/25/2011			6.28	21		3	56		0.022	0.1		
BERT-4	2/9/2011			5.25			0.3	52		0.004	0.5		

Station ID	Activity Date	E Coli (col/100mL)	Chl A (µg/l)	Alk Tot (mg/l)	Hardness (mg/l)	CBOD ₅ (mg/l)	TSS (mg/l)	TDS (mg/l)	Total P (mg/l)	NO ₃ +NO ₂ N (mg/l)	NH ₃ -N (mg/l)	TKN (mg/l)	DRP (mg/l)
BERT-4	2/22/2011			8.28	14.9		2	47		0.004	0.5		
BERT-4	3/18/2011			5.11			2	34		0.042	0.5		
BERT-4	3/30/2011			6.56	10.8		3	43		0.021	0.5		
BERT-4	4/13/2011			7.89			3	47		0.004	0.5		
BERT-4	5/11/2011			9.99			2	44		0.004	0.5		
BERT-4	5/25/2011			12.98	14.4		3	55		0.016	0.5		
BERT-4	6/15/2011			20.73			0.3	54		0.023	0.5		
BERT-4	6/29/2011			22.83	19.6		5	53		0.035	0.5		
BERT-4	7/13/2011			15.58			1	83		0.036	0.5		
BERT-4	7/27/2011			13.25	27.7		4	71		0.035			
BERT-4	8/10/2011			13.09			5	63		0.17	0.5		
BERT-4	8/25/2011			21.62	23.1		3	58		0.021	0.5		
BERT-4	4/2/2012	178.2	0.53	8.87		2	1	44	0.009	0.018	0.007	0.141	0.007
BERT-4	5/8/2012	135.4	0.27	12	13	2	9	38	0.012	0.103	0.007	0.076	0.006
BERT-4	6/13/2012	63.7	5.34	13.7		2	7	78	0.031	0.054	0.008	0.226	0.007
BERT-4	8/8/2012	86	1.07	25.1		2	10	36	0.019	0.055	0.008	0.303	0.005
BERT-4	9/5/2012	290.9	0.53	54.7	15.3	2	14	80	0.025	0.28	0.008	0.105	0.005
BERT-4	10/2/2012	290.9	0.53	9.5		2	5	70	0.01	0.248	0.008	0.051	0.005
BERT-4	10/31/2012	35.5	0.1	14.5	18	2	1	66	0.011	0.005	0.008	0.041	0.004
BERT-4	12/4/2012			10.9	16.5		3	20	0.008	0.024	0.036	0.041	
BERT-4	12/17/2012			6.47	12.1		5	78	0.02	0.218	0.008	0.041	
BERT-4	1/9/2013			7.55	10.8		1	36	0.012	0.105	0.008	0.297	
BERT-4	1/22/2013			6.37	9.37		1	52	0.008	0.102	0.008	0.106	

Station ID	Activity Date	E Coli (col/100mL)	Chl A (µg/l)	Alk Tot (mg/l)	Hardness (mg/l)	CBOD ₅ (mg/l)	TSS (mg/l)	TDS (mg/l)	Total P (mg/l)	NO ₃ +NO ₂ N (mg/l)	NH ₃ -N (mg/l)	TKN (mg/l)	DRP (mg/l)
BERT-4	2/5/2013			7.12	10.2		1	42	0.006	0.071	0.036	0.064	
BERT-4	2/19/2013			6.52	9.43		1	76	0.022	0.069	0.008	0.041	

Table 7-7. ADEM Reference Station Metals Data for Ecoregion 65i

Station ID	Activity Date	Ag Dissolved (µg/l)	Al Total (mg/l)	Fe Dissolved (mg/l)	Fe Total (mg/l)	Hg Dissolved (µg/l)	Mn Dissolved (mg/l)	Mn Total (mg/l)
BERT-4	3/20/2002		0.2	0.1	0.336	0.3		
BERT-4	4/18/2002		0.2	0.103	0.463	0.3		
BERT-4	6/6/2002		0.2	0.405	0.934	0.3		
BERT-4	7/2/2002		0.408	0.109	0.771	0.3		
BERT-4	8/8/2002		2.4	0.769	2.22	0.5	0.035	0.155
BERT-4	11/19/2002			0.071		0.4		
BERT-4	3/11/2003	15	1.556	6.75	1.126	0.5	0.041	0.03
BERT-4	4/7/2003	15	5.619	0.09	4.055	0.5	0.02	0.113
BERT-4	6/16/2003	15	0.931	0.082	0.69	0.3	0.02	0.027
BERT-4	8/12/2003	100	0.1	0.943	1.461	0.01	0.05	0.05
BERT-4	11/20/2003	50	2.46	0.201	1.917	0.01	0.05	0.05
BERT-4	1/25/2011	0.015	0.141		0.241			0.04
BERT-4	2/22/2011	0.015	0.133		0.37			0.007
BERT-4	3/30/2011	0.015	0.217		0.244			0.019
BERT-4	5/25/2011	0.015	0.067		0.548			0.028
BERT-4	6/29/2011	0.015	0.116		0.463			0.041
BERT-4	7/27/2011	0.015	0.143		0.609			0.049
BERT-4	8/25/2011	0.015	0.329		0.682			0.101

Station ID	Activity Date	Ag Dissolved (µg/l)	Al Total (mg/l)	Fe Dissolved (mg/l)	Fe Total (mg/l)	Hg Dissolved (µg/l)	Mn Dissolved (mg/l)	Mn Total (mg/l)
BERT-4	5/8/2012	0.015	0.043	0.019	0.308	0.035	0.016	0.022
BERT-4	9/5/2012	0.215	1.37	0.085	1.86	0.035	0.02	0.039
BERT-4	10/31/2012	0.215	0.165	0.699	1.19	0.035	0.043	0.051
BERT-4	12/4/2012	0.215	0.088		0.548			0.016
BERT-4	12/17/2012	0.215	1.02		1.12			0.043
BERT-4	1/9/2013	0.215	0.465		0.742			0.048
BERT-4	1/22/2013	0.215	0.255		0.385			0.028
BERT-4	2/5/2013	0.215	0.306		0.455			0.027
BERT-4	2/19/2013	0.826	0.58		0.725			0.025